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ABSTRACT

The technological-driven future will evolve through the next decades to massively impact elementary and secondary education, starting in the 1980 decade and building toward revolutionizing education in the 1990 decade. The evolving "silicon revolution" is producing a continuing list of new electronic technology poised at the threshold for massive application throughout society--including the expectation for transforming elementary, secondary and vocational education for both the short-term and long-term futures. The major new thrust is the emergence and growth of "smart machines." Technology for education which includes embedding increasingly capable, but physically small, microprocessor logic, digital storage/memory, sensors, communications circuits and links, and eventually voice actuated and reply mechanisms for creating convivially smart machines which are more humanistic for students. As modern technology advances, the synergistic relationship between humans and machines allows us to do more with less. This new human-machine symbiosis will change most institutions in society, including education. (Author/BMW)

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LONG-TERM ELECTRONIC TECHNOLOGY TRENDS:
FORECASTED IMPACTS ON EDUCATION

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ISSUE BRIEF CONTENTS

INTRODUCTORY REMARKS
FUTURE TECHNOLOGY FOR EDUCATION
EDUCATIONAL POLICY ISSUES AND RECOMMENDATIONS

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
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INTRODUCTORY REMARKS

This paper is about the technological driven future, now being grown, which will evolve through the next decades to massively impact elementary and secondary education, starting in the 1980 decade, and building toward revolutionizing education in the 1990 decade.

The evolving "silicon revolution" is producing a continuing list of new electronic technology poised at the threshold for massive application throughout society - including the expectation for transforming elementary, secondary and vocational education for both the short-term and long-term futures. The major new thrust forecasted to wend its way throughout the next two decades is the emergence and growth of "smart machines." Technology for education which includes imbedding increasingly capable, but physically small, microprocessor logic, digital storage/memory, sensors, communications circuits and links, and eventually voice actuated and reply mechanisms for creating convivially smart machines - which are more humanistic for students.

As modern technology advances along its evolutionary course, amplifying what humans do by adding to our tool kit smarter machines, the synergistic relationship between human and machines allows us to do more with less. This new human-machine symbiosis will change most institutions in society, including education.

Today education is dollar intensive, labor intensive and energy intensive. Inflation is increasingly reducing what we can do in education, and as a result, many schools are deleting functions. Teacher (and other school personnel) costs are rapidly climbing with energy costs increasing even faster. Knowledge is growing ever more rapidly giving society new abilities to increase its QOL and at the same time, obsoleting quickly what was learned just a few years ago. Society is becoming more complex. Society is also learning that we must do something about the future ahead of its arrival which further complicates societal management. Additionally, the future under consideration grows in terms of the number of alternatives available the farther we look into the future. All such considerations point to the growing dependence upon education, and the need for education to offer more for students - even at the elementary and secondary levels as well as for adults throughout ones life. Such trends point in only one direction. We need to raise the productivity of education so that we have the means to deliver more education. This, of course, means that the delivery system of education must be advanced - as do the courses being offered and considered as basic. In fact, we need to add to the list of basic courses of study, at all education levels. Nevertheless, to raise the productivity of education means displacement of teachers and other people in education - because the only viable long-term method for raising the productivity of education is to reduce the amount of labor expended per unit of education delivered. This does not automatically imply that fewer teachers will be required in the future. What this does mean, is that many, many jobs will be changed

in order to deliver more education, at each level, and to implement a life long approach to education rather than staying with the "inoculate the youth" only scenario of education.

But, it must be reiterated, advances in the delivery system of education using electronics (computers and communication systems) will displace people in education in order to raise the productivity of the educational dollar. Further, in order to raise the productivity of energy, future electronic educational delivery systems will increasingly be used to displace physical buildings.

In this new information era, computers, data- and tele-communications will be even more closely united and integrated with us, thus affecting and transforming much of the technological fabric of society, changing many aspects of human behavior, and thereby plunging society deeper into a cybernetic "smart machine" revolution. . . Few areas of the world society will be left unscathed. . . The concept of life-long learning will of necessity be merged and incorporated into the realms of both work and leisure time activities. Education may well become an integral part of everyone's daily life-style, becoming real-time and life-long in nature and formal in implementation at all educational levels.

This brief issues paper will only outline the future technologies forecasted to impact education, and then present a number of relative issues for education that soon must be considered from policy viewpoints.

FUTURE TECHNOLOGY FOR EDUCATION

Rapid advances in the technology of digital circuits, digital transmission, fiber optics, semiconductors, communication oriented/

integrated computers, communication satellites, computer mail, office-of-the-future, word processing, computer conferencing, packet switching/networks, loosely coupled computer networks, - to name a few - are driving fast to impact, change, and advance all forms of communications systems, including data communications. The resulting technology-driven future increasingly tends toward supporting the information society by putting greater reliance on both tele- and data-communications, as well as data processing.

From extrapolations of microelectronic (silicon) technology, trends toward the next four hardware revolutions now visible for the 1980's are mappable as to their expected leading edge of technological occurrence, major characteristics, and resulting downstream major impacts for the 1980 and 1990 decades on education and society. The four future hardware (technology-driven) revolutions are:

- 1) 1979/81 - Component processors leading to smart machines, people appliances (e.g. smart teacher machines, smart student machines, etc.), source data automation devices, smart communications systems, and microelectronics for imbedding in educational machines for making them smarter.
- 2) 1981/83 - Component computers forcing universal computer systems leading to educational programs cast in hardware, smart data processing systems, smart management machines, and computer components for creating smart educational systems and institutions.
- 3) 1983/85 - Component memory which revolutionizes communications, leading to educational information appliances, smart

memory, educational knowledge based systems, and future offices and schools becoming portable machines later in the 1990 decade.

- 4) 1985/88 - Component systems which further revolutionize educational institutions by forcing economy-of-scales favoring small systems and which allows future factories to become computerized communication oriented machines in the 1990 decade.

Obviously, such major technological transitions now forecastable and scientifically/technologically feasible for the near-term future portend significant long-term future impacts on society and future education.

Smarter and smaller, downward sliding price per function, more memory and friendlier computer systems and peripherals is the trend. Future computers will have, thrown into this bargain also, easier-to-use functionality, increased reliability, and sharp cuts in weight as well as power consumption. As such, computers turn into helpers to be imbedded and incorporated into other things. Later in the 1980 decade, computer systems, as well as the communication systems and the peripherals they smarten up, will/could become fault-tolerant (fail safe) enough to be self-repairable. Further, they will spawn advanced forms of data/telecommunications linked people amplifier devices, information appliances, information or knowledge based (beyond data base) systems, decision support systems, and the like, for education.

Further, as next generation calculators become more complex and sophisticated, at least one trend should be toward smart people amplifier devices. This category of future computers or smart machines, includes wearable or carriable smart teacher machines, smart student machines, smart management machines, smart programmer machines, smart doctor machines, smart auditor machines, smart health machines, smart politician machines, smart systems design machines, smart accountant machines, smart secretary machines, smart marketeer machines - this list goes on and on. As large capacity (but not physically large) memory components are added to these smart people amplifier machines together with direct (data) communications circuitry, these machines become information appliances for education. Further, as society begins to massively apply and distribute these calculator spawned future smart people appliances, the need for bigger and smarter data processors and memory also goes up, as well as the need for more data communications to link the little ones with other little ones and with the big ones and to link them all with "electronic libraries" and "electronic schools."

Eventually such computerized information appliances could well obsolete the physical school and office by allowing it to be worn or carried by each of us, as well as, students at all educational levels. Obviously, such a future allows the productivity of energy to be greatly increased via substituting information appliances and data communications for buildings (and their construction cost of energy and materials and the energy that would otherwise be needed to heat, cool, and maintain them). Sometime towards the end of the 1980 decade

or early in the 1990's, such information appliances, together with their associated knowledge banks (electronic libraries), should cost less than what it now costs for what we spend for energy to travel back-and-forth to the school or office. Obviously such a trend, obsoleting geographically located school and office buildings, will have drastic, revolutionary, and lasting future impacts on business, management, society, and education.

The most likely scenario for these machines, in their entry into the marketplace, will be in an evolutionary wave upon wave of products analogous to the early LSI digital calculator. That is, the first ones are likely to have four (or so) basic primitive functions incorporated that, for example, the educator would be hard pressed to be without - and these first smart educational machines would probably cost a few hundred dollars. Then, when the price erodes to less than \$25, a new smart educational machine is introduced with an additional set of 10 to 20 primitives, and, of course, the price is again a few hundred dollars. When this smart machine's price drops to below \$50, another is introduced with many more primitives and again at a higher price. In the meantime, either in parallel or serially, or both, other smart people amplifier machines are also introduced for amplifying the other professions and as student aids for learning. Such a future can start early in the 1980 decade and continue throughout the 1980 decade and on into the 1990's.

With the addition of considerable memory for holding massive amounts of data for instant playback, referrals, and dialoguing, together with some form of communication link, a people amplifier

device turns into an information appliance. Such a device puts at the finger tips (so to speak) what society knows (has learned) so it can be used in the real-time of whatever the person or student is doing who is using such a device.

The current trend towards advanced data banks, data base systems, data management systems, relational data bases, integrated next generation operating systems, management information systems, information applications, distributed memory systems, and distributed data bases tends to point forward to a new era. Extrapolation of these advances points to such new technological forms as:

- o Smart data bases
- o Smart operating systems - smart information and processing support systems for education
- o Smart integrated administration, process, management, and student systems
- o Knowledge base systems for education
- o Decision support systems
- o School/office-of-the-future

That is, for the future many things which were heretofore individual options for data processing or businessss are beginning to merge (be integrated) into knowledge based decision support systems.

In total, this collection makes for a considerably smarter memory. Included is considerable amounts of educational application programs for turning the data into useful information or knowledge, consisting of:

- o CAI - Computer assisted instruction for real-time teaching the user (e.g. the elementary or secondary student) about the data

bank usage for turning the data into useful knowledge for real-time application by the student

- o CAD (Computer aided design) and Simulation - To allow the student or decision maker to ask of the knowledge bank the "what if type" questions to allow testing of decisions before deciding and to allow students to "dialogue" with societies stored knowledge
- o AI - Artificial intelligence type routines to allow the knowledge base to learn about each different user - included also will be various forms of machine aided cognition routines so that the system can usefully converse with each individual student
- o Application Specials - A lengthy list of education courseware to form or change specialized data into useful knowledge

Knowledge base systems naturally will not start out as a full blown system, as described above, but in all likelihood will evolve over a number of years.

The growth in usage and evolutionary design advance of educational knowledge based systems will keep educators in business for a very long period into the future, but their job will be altered. The growing remote connection of information appliances with knowledge based systems for education will expand and feed upon each to grow each in the future and thus change drastically education in the future.

The merger of CAI (computer assisted instruction), word processing and data processing will change the school environment and is bringing

varied versions of the future school. Obviously, there will be many transitions on the road to the future school - offices and schools will be recast many times, now that we are beginning to learn how to raise the productivity of education delivery systems, school personnel and office personnel with future technology of evolving computer and communications logics.

Progressively, the school-of-the-future and office-of-the-future will emerge and change through the addition of:

- o Advanced forms of CAI
- o Word processing merged with data processing and CAI
- o Distributed data bases
- o Smart school and office machines, like:
 - Smart teacher and student machines
 - Smart typewriters - voice recognition, smart talking typewriters
 - Smart file cabinets - paper files replaced with electronic mass storage and display medias which are paperless - paperless office media systems
 - Smart transaction machine
 - Smart order processing machine
 - Smart secretary machine
- o Information appliances
- o Knowledge based systems
- o Paperless offices and schools
- o Remotable and wearable/carriable offices

Whatever the form of the future school-of-the-future and the office-of-the-future, each will be enhanced as the other expands - and

their futures are not entirely separable. Thus there is afoot a tacit strategic plan to put school and office clerks and professionals alike out of business for the long range future - because of the perceived economic need and requirement to raise the productivity of education, energy and the office. This does not imply, however that all school and office clerks nor professionals will be eliminated - but many will be, or at least displaced into new roles.

But what lies beyond our present conception of the school-of-the-future or office-of-the-future? Is it the total elimination of the physical school or office through the technological advent of the information appliance? That is, the school or office function of one form or another may continue, but its physical embodiment of a fixed (geographically located) building could very well disappear. What is the forcing function for such a future? Obviously it is: 1) the advances in technology forecastable will economically and feasibly allow it; 2) there will be great material and energy savings when society need no longer build so many second homes (called offices or schools) nor need to heat, cool or maintain them; and 3) the cost of a remotable wearable/carriable school or office as a future information appliance would cost less for the appliance than we now expend for the energy to travel back and forth to and from schools and offices. Thus, once advances in science and technology allow such an alternative, it could well become the gravity flow of society because of the huge savings involved, especially for the energy-deprived future we are forecasted to be moving into. Is there any holding back of this future once it starts?

EDUCATIONAL POLICY ISSUES AND RECOMMENDATIONS

Such forecasted rapid advances in technology leading to massive application of computer and data communications will of certainty cause both massive and widespread future impacts on elementary and secondary education - and the rest of society. Why in the 1980 decade? Wasn't computer technology advancing rapidly also in the 1960 and 1970 decades? In the past, when computers cost millions of dollars and student terminals cost ten's of thousands of dollars, few could afford such technology. Now we can forecast computers for education, for sometime soon in the 1980 decade, costing only thousand's of dollars and thereafter even less - and student appliances (portable computer connected terminals) costing in the range of hundred's of dollars and eventually ten's of dollars. Thus, such modern technology can now be forecasted to soon pass through the threshold of affordability for schools, families and students. (Already home computers, in the range of a little over a thousand dollars are beginning to be used by a growing number of families.) As future computer and communications technology advances further, and cost barriers tumble and slide even more, there should be little doubt that such sophisticated technology will be on a rapid growth path of usage by schools and students. As a result, schools-of-the-future will be transformed in the process and future students will be assisted with such technology in their learning efforts. Because we can now forecast such rapid change resulting from the penetration of new technology into elementary and secondary education many new educational policy issues are raised and soon must be faced, resolved and enacted. In what follows, a

number of such policy issues and recommendations are presented:

- 1) Establishing national educational policy goals that encourages the use of advanced technology for raising the productivity of energy and education through the orderly and increasing use of future technology for elementary and secondary education.
- 2) Increase the strategic stockpile of advancing technology for elementary and secondary education by establishing policy for encouraging (a sort of) an Education-Industrial complex which; a) develops a national planned and directed approach for developing educational technology cooperatively with industry, and b) encourages educational technology R & D. (Today, education is largely dependent on what industry supplies rather than education deciding what is needed to be developed.)
- 3) Develop policy which encourages the institutions to develop the software (SW) and courseware (CW) which will be required for electronic delivered education, such that the needed SW and CW is developed in concert with new hardware innovations. (Today, a major problem in using computers in education is that CW lags by many years hardware developments and thus paces their worth to education - usually the lag is so long that such systems are out of date when the SW and CW becomes available.)
- 4) Perform R & D to determine the primitive functions needed for incorporation into future educational systems (e.g. smart

people amplifiers and information appliances) for assisting students in learning situations and for aiding teachers in teaching.

- 5) Enact policy for encouraging the development of and for creating elementary and secondary educational alternatives through advances in technology.
- 6) Develop educational policy to remove the threats of new technology usage at the elementary and secondary levels, such as; a) forecasted new technology will allow educational delivery systems to be both less labor and less energy intensive. This means people, including teachers will be displaced. However with foresight planning and appropriate policy goals, new roles for the displaced persons can be mapped for increasing the effectiveness of education and for creating the massive amounts of electronic educational software and courseware which will be required - and which will be needed to be constantly updated.
- 7) Establish communications policy (data- and tele-communications) and computer policy for encouraging the timely usage in education of future rapid technology developments.
- 8) Develop policy for establishing national educational electronic computer communication networks for "school" sharing of electronic courseware and the delivery of certain elements of education.
- 9) Develop national educational policy for future remotely delivered education into homes (and elsewhere) as technology

emerges for implementing the alternative of non-school-building-schools. (Already CW is being developed for home computers which can be forecasted to impact education.)

- 10) Develop policy and R & D strategies for:
 - a) Future Electronic Educational delivery systems - computer assisted communications delivered education systems
 - b) Future computer-communications "babysitter" oriented electronic educational systems
- 11) Develop education policy which allows the timely and orderly (but rapid incorporation) implementation of future technological developments, such that elementary and secondary education can reap early benefits from technological innovations.
- 12) Develop national policy to establish the new boundaries and roles that will emerge and change as electronic technology moves into elementary and secondary relative to national (HEW), state education departments, local school boards and schools as such boundaries become increasingly blurred.
- 13) Develop policy towards creating opportunities for taking care of the critical task of updating the massive numbers of teachers who will increasingly become impacted by new technology.

BIBLIOGRAPHY

Harkins, Arthur, and Wroblewski, Elizabeth, "Electronics, Babysitting, and the Future of Teaching," UNIVERSITY OF MINNESOTA, January 1979.

Illich, Ivan, TOOLS FOR CONVIVIALITY, New York: Harper and Row, 1973.

Joseph, Earl C., "CAI's Future," TRAINING HRD, Special Report, September 1977.

Joseph, Earl C., "Future Computer Systems: Beyond The Next Five Years," FUTURE SYSTEMS (INFOTECH State-of-the-Art Report, 1977).

Joseph, Earl C., "Future Smart Systems," DATA MANAGEMENT, January 1978.

Joseph, Earl C., "Microprocessor/Computer Futures: Trends Toward Smarter Systems," Prepared For: JOINT DEFENSE R&E INTELLIGENCE COMMUNITY TECHNOLOGY TRENDS COLLOQUIUM, March 29-April 1, 1978.

Joseph, Earl C., "Small-Is-Beautiful Futures With Convivially Smart Systems," REVUE CRITERE, Montreal, Quebec, 1978.

Joseph, Earl C., "Chapter III: Some Projections For Deciding Future Alternatives for Industrial Arts," A.C.I.A.T.E. 25TH YEARBOOK, 1975.

Schumacher, E. E., SMALL IS BEAUTIFUL: Economics as if People Mattered, New York: Harper and Row, 1973.